The work of the station is carried on as follows:

Every day, before the flights are begun, the wind conditions as high up as possible are determined, either from the movement of the clouds or, preferably, by means of pilot balloons. We thus decide whether we had better send up a kite or a captive balloon; taking into account the fact that the boat must be run as short a distance as practicable, in order to economize coal. We also decide from what point on the lake the flight should be begun so as to have as much room as possible for the vessel to run in and not be obliged to abandon the flight prematurely on account of nearness to the shore. During the summer months we have, as a rule, used captive balloons of rubber-coated cotton or silk, and having a capacity of 30 to 50 cubic meters. As they have a vertical ascensional velocity of about 3 meters per second the ventilation thus produced fully suffices to prevent the effects of solar radiation. In many cases, however, a small electric ventilator is sent up with the apparatus. In winter we shall more often use kites of the Marvin and Hargrave types, having 5 to 7 square meters lifting surface. Our captive balloons have attained altitudes as great as 4,000 meters, but with kites we have not yet gone higher than about 3,000 meters.

The results of the ascents are promptly transcribed and telegraphed to the meteorological central stations of southern Germany (Strassburg, Karlsruhe, Stuttgart, and Munich), the Deutsche Seewarte at Hamburg, the Lindenberg aeronautical observatory, and several of the Public Weather Service centers in northern Germany. Our telegraphic reports have generally been early enough to use in making the weather forecast issued between 10 and 11 a. m.

The station owes its existence to the efforts of Professor Hergesell, who as early as 1901, in collaboration with Count Zeppelin, flew kites—without instruments, however—from a small motor boat on this lake. The station was erected and has been maintained by contributions from the Imperial Government and the governments of the four South German States, Bavaria, Württemberg, Baden, and Alsace-Lorraine. It is located at Friedrichshafen, in Württemberg, and is under the administration of Württemberg. The station building, see fig. 2, which includes workshops and the necessary offices, stands on the harbor front, close to the anchorage of the kite-boat. The latter is of the torpedo-boat type, is 27 meters long, 3.4 meters beam, and has an engine of about 350 horsepower. It has a maximum speed of 19 knots. The reel is driven by an electric motor. The vessel was especially designed for kite and balloon flights, was built in 1907 at the Schichau yards, in Elbing, and cost 72,000 marks, or $18,000. It is named *Gna*—after one of the messengers of the gods in the northern mythology.

THE REFLECTING POWER OF CLOUDS.

The following article is compiled from the note of May 27, 1908, recently distributed by Messrs. C. G. Abbott and F. E. Fowle, jr., from the Smithsonian Astrophysical Observatory at Washington, D. C.—*C. A.*

The diffused reflection and radiations from fog and cloud and even dusty air, are of appreciable importance in dynamic meteorology and even climatology. They are so analogous to those from solid matt surfaces that the formulas given by Abbott and Fowle must closely represent the natural intensity when the incident light is homogeneous and the cloud particles are much larger than the incident wave lengths.

A perfect matt surface may be defined as one which reflects diffusely the whole of the radiation incident upon it, in such a manner that equal solid angles observed on such a surface contribute equal amounts of reflected radiation, independent of the nadir distance.

Let AB, in fig. 1, represent an infinitely extensive plane of perfectly matt surface; let CD represent an infinitely extensive plane parallel to the plane AB. Let *a*, *b*, *c*, *d*, be four equal areas situated so that *ac* is normal to AB and the angles *dac* and *bca* are equal. Let them be represented by the symbol *i*. Let the zenith distance of the sun be Z and let K be the amount of radiation it sends to an area equal to *a* situated at right angles to the solar beam. Then the amount of solar radiation on *a*, or *b*, is $K \cos Z$.

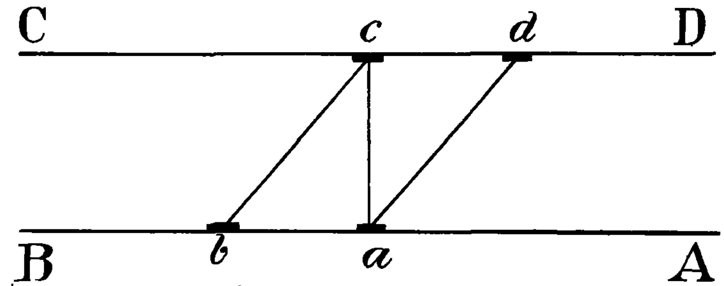

FIG. 1.—Reflecting power of clouds.

By diffuse reflection the area *a* sends the same amount of radiation to the area *d* that *b* sends to *c*. A ring drawn in the plane CD about *c* as a center, with a radius equal to *cd* would contain as many areas equal to *d* as a similar ring drawn about *a* as a center in the plane AB. For each such area situated in the upper ring in a given position with regard to *a* as a center in the plane AB. For each such area situated in the upper ring in a given position with regard to *a*, there is an area on the lower ring to which *c* bears exactly the same relation of position. From this it follows that the sum of all the radiation received by *c* is equal to the sum of all the radiation diffusely reflected by *a*; and this, since the surface AB is a perfect matt surface, is equal to the total amount of solar which falls on *a*.

Let Q be the amount of diffusely reflected radiation which a surface of the area *c* would receive if directed toward an area of the surface AB subtending a solid angle equal to that of the sun. Let α be the angular semidiameter of the sun. Then the angular area of the sun is $\pi\alpha^2$.

For an element of angular area upon the plane AB at nadir distance i and azimuth A the expression is $\sin i \,.\, di \,.\, dA$. Such an element will reflect upon the horizontal area *c* the amount of radiation

$$\frac{Q \sin i \,.\cos i \,.\, di \,.\, dA}{\pi\alpha^2}.$$

Hence, the total reflection upon *c* is

$$\frac{4Q}{\pi\alpha^2}\int_0^{\frac{\pi}{2}}\int_0^{\frac{\pi}{2}} \sin i \,.\cos i \,.\, di \,.\, dA = \frac{Q}{\alpha^2}$$

Hence,

$$\frac{Q}{\alpha^2} = K \cos Z$$

and

$$Q = K\alpha^2 \cos Z.$$

Then, neglecting the difference in height above sea level between the cloud and the observer, every area of a perfectly matt cloud subtending a solid angle equal to that of the sun, would reflect to the measuring instrument an amount of radiation $\alpha^2 \cos Z$ times the amount of radiation received directly from the sun, provided both the direct and the reflected beams were observed at normal incidence. On August 22, 1906, α^2 was 0.0000206.

But an allowance must be made for the loss of intensity of the beam in its course from the level of the observer to the cloud and thence back to the level of the observer, and for the considerable difference of level of the cloud of August 22, 1906, and the observing station. In fact this correction would be large. While no accurate measurements were made, it is thought that the difference of level on that date was about 1,500 feet. The air pressure corresponding to this difference of level would be about 0.055 of the barometric pressure above Mount Wilson. According to the pyrheliometry of August 21 and 23, 1906, we may estimate the general atmospheric transmission coefficient for August 22 as 0.90 for vertical transmission thru all the air above Mount Wilson. Hence, for vertical transmission thru the layer in question the transmission may be estimated at $(0.90)^{0.055}=0.994$.

For the very large angles of zenith distance Z, and nadir distance i, the paths of the beam in this layer ought not to be taken as simply proportional to ($\sec Z + \sec i$), and we shall rather use the air-mass values of Laplace as given by Radau in his "Actinometrie," altho these are also of doubtful application in the present instance. Let us call the air-mass $\varphi(Z)+\varphi(i)$, where φ is a function to be taken from the above sources. Then the values of reflection given for August 22, 1906, in Table 25 of the Annals, are to be increased in the ratio

$$\frac{1}{0.994[\varphi(Z)+\varphi(i)]}$$

to allow for the difference of level. No correction of this kind is thought necessary for the values of September 13, 1906, as the cloud was practically at the level of the observer.

An entirely new set of apparatus for measuring the reflecting power of clouds is now in place at Mount Wilson, and we hope to obtain a great many additional measurements there this year. We therefore refrain from computing at present a new value of cloud reflection and of the albedo of the earth from the observations of 1906.

EARLY METEOROLOGY AT HARVARD COLLEGE. 2.

By B. M. VARNEY, Assistant in Meteorology. Dated Cambridge, Mass., September 10, 1908.

In a recent article[1] on the early history of meteorology at Harvard College the writer mentioned the announcement of lectures by Isaac Greenwood, the first Hollis Professor of Mathematics and Natural Philosophy. While the strictly meteorological subjects comprise but a small part of this announcement, and therefore presumably of the lectures, it is probably one of the oldest extant records of scientific lectures in this country and thus has considerable historical interest. A few pertinent historical notes which the writer has been able to gather follow the "Syllabus." The absence of a full text of the lectures and of contemporaneous accounts of them renders a detailed study impossible.

A

Course of Philosophical Lectures,

with a great Variety of

Curious Experiments,

Illustrating and *Confirming*

Sir ISAAC NEWTON'S *Laws*

OF

MATTER AND MOTION.

By ISAAC GREENWOOD, *A. M., &c.*

ARTICLE I.

Of the FUNDAMENTAL PRINCIPLES *of* MATTER

Where the essential Properties *of* Space *and* natural Bodies, *are shewn, in a great variety of* Experiments: *And the* NEWTONIAN LAWS of Matter *demonstrated.*

I. *Of the* ESSENTIAL PROPERTIES *of Space and* natural Bodies.

[1] See Monthly Weather Review, May, 1908, XXXVI, p. 140.

LECTURE I.

OF EXTENSION—The Manner of *Conceiving* and the *real Proof* of a *Vacuum*, by several *curious Experiments*—The *inconceivable Divisibility* of the Parts of Matter, shewn in *natural* and *artificial Instances*, by a Sett of *microscopical Observations*, and prov'd by Dr. *Neiuwentyt's Experiment* of the *Division* of Water, by the *Ælopile;* on which *Principle* the *Operation* of the celebrated *Engine to raise Water by Fire*, will be explained in a very large *Cutt* thereof.

Lecture 2. Of the SOLIDITY and POROSITY of *natural Bodies* in many *useful Experiments* and *critical Remarks*; where particular Notice will be taken of the *Alterations* they are subject to by *Heat* and *Cold, Dryness* and *Humidity, Weight* and *Levity*, in many *curious Experiments.* And of the STRUCTURE and FORMS of *natural Bodies,*—their *inward Disposition,—external Configuration*, with a Variety of *Experiments* relating to the *Changes* of their *Forms* on many Considerations.

II. *Of the* NEWTONIAN LAWS *of* MATTER.

Lecture 3. Of the *Fundamental* LAW; viz. GRAVITY or GRAVITATION, (where all its *Properties* will be *very particularly* illustrated and confirmed) together with the other two *General Laws*; viz. the COHÆSION and REPULSION existing between the *minute Parts* of *Matter*, in a great Variety of *Experiments.*

Lecture 4. Of the SPECIAL LAWS of MATTER; viz. MAGNETISM and ELECTRICITY; where their *surprising* and most curious *Phænomena* are shewn in a Sett of very useful and *delightful Experiments* of *late Invention.*

ARTICLE II.

Of the FUNDAMENTAL PRINCIPLES *of* MOTION.

I. *The* Principals *of* MECHANICS.

Lecture 5. *Explanations* of *necessary Terms*, with many *Experiments* relating to the *Places* of the *mechannic Centers* of Bodies, their *Velocities, Quantities of Matter*, and *Momenta* of *Motion.*—The *Fundamental Propositions* relating thereunto, proved on proper *Machines—Experiments* about the *falling, sliding,* and *rolling* of *Natural* Bodies, &c., very *curious*; the *Solution* of several entertaining *Problems*, relating to *Animal Motion* and *Action*; with a Conclusion concerning the Explanation of the *Motion* of the *Astronomical Bodies* on these *Principles.*

Lecture 6. A full *Explanation* with many *Experiments*, on the *Five Mechanical Powers* or *Simple Machines*; viz. the *several Kinds* of *Ballances, Levers, Pullies, Wheels* and *Axles, Wedges* or *Screws*; of *Compound Machines*; and the *Invention* and *Use* of many *useful* and *curious Engines.*

II. *Of the* NEWTONIAN STATICS.

Lecture 7. Of *absolute and relative motion.*

Sir ISAAC NEWTON'S

1. *Law of Motion*, viz. *That all Bodies continue in the State of Motion or Rest, uniformly, in a right Line, except* so *much as that State is Chang'd by Forces impress'd*; with many *Examples* and *Experiments*; Of the great Use thereof in the *Motion of Bodies* proceeding from *single* and *Compound Impulses.* Of the *Phænomena* of *Diagonal Motion* and *oblique Powers.*

2. *Law of* Motion, viz. *That the Change of Motion is always proportional to the moving Force impress'd; and is always made in the right Line in which that Force is impress'd.* Of the *Phænomena* of *Accelerated* and *Retarded Motion.*

Of Projectile Motions.

Lecture 8. Of *oblique Descents*; where all the curious *Experiments* and *Observations* relating to *Pendulums* and their *Uses*, will be made. Of *Circular* and *Elliptical Motion*, with many *Experiments.* Dr. *Desagulier's* celebrated *Experi-*